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Mathematics in the Malay World Prior to the Arrival of Western Mathematics

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Abstract

The Malay world comprises the modern day Indonesia, Malaysia, Brunei, Singapore, Philippines, Thailand and Kampuchea. The subject of mathematics was taught and studied in this region in conjunction with other branches of knowledge especially those that are related to the Islamic jurisprudence, before the arrival of western mathematics. Islamic mathematics came into the Malay world through the efforts of religious scholars from this part of the world that had gone to the Middle East to study theology. They mastered the mathematics of the day in its original form in an integrated manner with branches of theology. Whatever was learnt in the Middle East was brought back and disseminated to students in the traditional schools. Among the works collected and brought back were reference books on a variety of branches of mathematics especially from Makkah, Madinah and al-Azhar University. They became the references for the teachers in imparting their mathematical knowledge to their students. The serious efforts and quality of works of the early Malay scholars in the field of mathematics can be gleaned through the few manuscripts that have survived to this day.

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1. Introduction

The Malay World comprises countries which are now known as Malaysia, Indonesia, Brunei, Singapore, Thailand, Philippines, and Kampuchea. This part of the world is also known as *Nusantara* or *Pascabima*. Ptolemy, an Egyptian geographer visited the Malay world in the second century A.D and called it “*Golden Chersonese*” (*Semenanjung Emas* in Malay – a beautiful golden peninsula) for its beauty and greenness. The Indian travelers once referred to it as *Sunarbubumi* which can be translated as the same meaning as Ptolemy's. The significance of this area in ancient history as a meeting place for sea travelers between east and west is due to its strategic location between India and China. The region went through its own history under many religious influences such as Hinduism, Buddhism and Islam. It is recorded that Islam came to this region in the very early period of Umayyad caliphate when a Srivijayan king embraced Islam during the reign of Caliph Umar ibn al-Aziz (A.D. 717 - 720) or

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even earlier according to other sources. Since then, Islam gradually became an important religion in the region. Religious matters, such as compulsory charity (zakat), inheritance problems (farā'id), and crescent sighting to mark a new month in the lunar calendar needed knowledge of systematic mathematical calculation. For these purposes, the works of al-Khwārizmī, Ibn al-Bannā', al-Turtūsī, Ibn al-Hā'im, Ulugh beg and Ibn al-Yāsamin in algebra, mathematics and astronomy were frequently cited by Malay writers.

Text books in algebra and arithmetic such as *Khulāsah al-Hisāb* (A Concise Treatise on Mathematics) by al-'Āmilī, *Talqīh al-Afkār* (Combining Ideas) and *al-Urjūyah al-Yāsaminīyyah* (The Poems of al-Yāsamin) by Ibn al-Yāsamin, *Tuhfah al-A'dād li dhawī al-Rushd wa al-Rashād* (A Special Arithmetic for the Wise and the Rightly Guided) by Ibn Hamzah al-Maghribī, *Kashf al-Asrār* (Unveiling of secrets) by al-Qalsaldī, *Talkhīs al-Hisāb* (Purification of Mathematics) / (Understanding Mathematics) by Ibn al-Bannā', al-Marrākīshī, and *Murshid al-Tālib ila Asnā al-Mutālib* (Students' Guide to Excellence in the Pursuit of Knowledge) by Ibn al-Hā'im, were among frequent quoted references by Malay writers (see our writing in Shaharir (2001)).

2. Islamic Mathematics

The beginning of the history of Islamic mathematics can be traced to the late 8th century. Among the earliest Muslim mathematicians was al-Khwārizmī (780-850 AD) who introduced a new system of numbering which greatly simplified the Roman one which had been widely used previously. The decimal system (*a'shā riyyah*) provided simplification in carrying out basic arithmetical operations. In the Islamic tradition of knowledge, religious scholars who were experts in the field of theology were also conversant with and masters of other areas of knowledge. These included astronomy, medicine, the arts, logic and rhetoric. Among those who fall into this category are al-Kindī (born 796 AD), al-Battānī (858- 929), Ibn al-Haitham (965-1038), al-Bīrūnī (973-1048), and Ibn Sina (11th century). By the 14th century the Islamic civilisation was already very rich in its mathematical knowledge.

The treatise by Ibn al Bannā' entitled *Raf'u al-Hijāb 'an A'māl al-Hisāb* (Unveiling the Cover in the Arts of Mathematics) or *Khulāsah al-Hisāb* by al-'Āmilī, discussed the subject of basic arithmetic and algebra. For example, the discussions on permutations and combinations in the book of Ibn al Bannā' (14th century) marks the first advance made by Islamic mathematics since the time of al-Khwārizmī. Islamic scholars continued to be active and productive in the field of mathematics until the 17th century when their involvement waned due to backlash in the political arena during that period and subsequent to it. Until that time, many outstanding treatises were produced and became references not only by contemporaneous scholars but also by mathematicians in the subsequent centuries. They played an outstanding role in shaping and providing directions for the future development of mathematics in the world. Muslim works were brought into Europe by early scholars by translating Arabic treatises into Latin. Leonardo Fibonacci was among the pioneers in this pursuit. Centres of learning set up in places such as Cordova, Toledo and other places in Spain became the focal point of convergence for western scholars to study the Islamic mathematics.

The development of mathematical knowledge in the Muslim world during that period helped to raise the standard of knowledge in areas of science and technology known then. This is especially evident for example in the field of astronomy. It is instrumental in elevating the scientific knowledge of the cosmos, in particular the movements of the stars and in the creation of scientific tools necessary in scientific works, at that time. From the inventions of sundials, quadrants, astrolabes to observatories the role of mathematics is very evident. Concerning the observatories Nasr (1976) quoted "Infact it can be said without exaggeration that the observatory as a scientific institution owes its birth to Islamic civilization. While in the early Islamic period the observatory was of a small size and usually associated with a single astronomer, from the 13th century and the building of the Marghah observatory by Nasir al-Din al-Tusi, it became a major scientific institution in which numerous scientists gathered to work and teach together. The Maraghah observatory served as a source of inspiration and model for the Ulugh-Beg observatory in Samarqand and the Istanbul observatory of the Ottoman period where Taqi al-Din worked. These observatories in turn ... were the model for the early European observatories such as those used by Tycho Brahe and

Kepler”. Hence the science of astronomy began in earnest during the Islamic civilization and whose growth is dependent on branches of mathematics such as geometry, arithmetic of logarithms and especially trigonometry has contributed much to elevate the understanding of mankind towards the nature of the movement of the stars and sister planets of earth to this day.

3. The Philosophy of Mathematics Education

The philosophy of learning mathematics in the Islamic world is closely linked to the concept of the relationship between Allah, The Supreme Being and man, His servant. A Muslim is always conscious of this relationship and of the fact that whatever he has at his disposal must be directed to the expression of his enslavement to Allah. Hence in the pursuit of knowledge he is always aware of his role and the roles of knowledge in glorifying the Supreme Being and the confines of his activities in this pursuit. Islam places high priority on the importance of learning. It is a religion whose understanding relies greatly on the grasp and the depth of one's knowledge of the physical and non-physical world. Hence the learning of mathematics became necessary in a Muslim's life, as this subject is a tool in enhancing one's understanding of the world. If one is aware that the world is a creation of Allah, one's understanding of the greatness and infinite wisdom of Allah will be further heightened by grasping the mathematics principles that describe Allah's creations. Also the knowledge one has mastered will make one better able to contribute to the development of one's society, which is also consonant with the teachings of the religion. Hence the positions of scholars and intellectuals rank high in an Islamic environment.

4. The spread of Islamic Mathematics into the Malay World

The spread of Islamic mathematics into the Malay world is not devoid of the above philosophy. This is because; Islamic mathematics came into the Malay world through the efforts of Malay religious scholars who had gone to the Middle East to study Islamic theology. They mastered the mathematics of the day in its original form and in an integrated manner with branches of theology. Whatever was learnt in the Middle East was brought back and disseminated to students in traditional schools. Among the works collected and brought back were books on a variety of branches of mathematics which had been their references during their study, especially in Mecca, Medina and the University of Al-Azhar. Some of them became writers and produced mathematical works based on their learning experience. Many of the written works were in the form of leaflets, short notes, and letters written in Malay using the Arabic script. These works came down to us through the descendants of these scholars. Though only a few manuscripts survived, they give us a glimpse of the serious efforts and quality of work of the early Malay scholars in mathematics.

5. Some Works of Malay Mathematicians of the 18th to 20th Centuries

The documentation of Islamic mathematics in the Malay World has to date not been completed. The earliest known record of a treatise in logic by a Malay writer, entitled '*Ilm al-Mantiq* (The Art of Logic), is dated 1593. However our searches for such treatises in mathematics written in the region mainly concentrate on surviving documents that are dated later than the 18th century at the moment. *Al-Sullam fi'l-Mantiq* by al-Akhdari (A Ladder to Logic) is a very well known text among the students of classical logic in the region. Syeikh Muhammad Nur al-Fatani is reported to write a commentary in logic based on the text. Logic is classified as an introductory element to many fields including mathematics and theology. An analysis of this text in view of modern notation of logic can be seen in Siti Mistima (2005). The study of the elements of logic in the Malay-Islamic culture can be found in our writing (2010). This is our early effort to define an ethnic and cultural-based study of thinking known as ethnologic.

The records tell us about the existence of a number of Malay mathematicians for the period between the 19th and mid 20th century. They were mathematicians who were also scholars in religious studies. Our early survey (Ismail (1995) showed that they originated mainly from Fatani/Patani (in southern Thailand), Sumatra Indonesia and Kelantan Malaysia. Some were also of Riau and Kampuchean origin. They were highly respected by the Malay community then and now because of their knowledge in religion as well as in other scholarly areas. Syeikh Daud al-

Fatani (b. 1720 AD), for example, was regarded as one of the great Malay scholars during that period. So were Syeikh Abdul Kadir al-Fatani (b. 1817 AD), Syeikh Muhammad Nur al-Fatani (born 1873), Faqih Wan Musa al-Fatani (second half of 19th century), and Syeikh Wan Ahmad Mohamad Zain al-Fatani (1856-1908). Another Malay scholar was Ahmad bin Abdul Latif al-Khatib al-Minangkabawi from Sumatra Indonesia. He is regarded as the greatest Malay mathematician of the 19th century. Syeikh Tahir Jalaluddin (1867-1957), also of Sumatran origin, who later settled down in peninsular Malaysia, was regarded as a fine Malay astronomer towards the end of the 19th century. So was 'Umar Nuruddin al-Kelantani.

An arithmetic text written by 'Abd Qādir 'Ali al-Sakhawī known as *Matn al-Sakhawīyyah* (The Shortened Version of Sakhawī) was rewritten by Sheikh Wan Ahmad bin Muhammad Zain of Patani with some significant commentaries and footnotes towards the end of 19th century. This book was a standard text in arithmetic and algebra among new students in Islamic schools. The commentator mentioned the book by Ibn al-Hā'im as one of the references in his commentary.

Mathematical works by Ahmad bin Abdul Latif al-Khatib al-Minangkabawi entitled '*Alam al-Hussāb* (The Banner for Mathematicians) (1892) and *Raudat al- Hussāb* (The Garden for Mathematicians) (1890) became the models for others to follow in the Malay world then. '*Alam al-Hussāb* was a Malay version of the Arabic *Raudat al- Hussāb*. Al-Khatib was the first Malay imam (prayer leader), Khatib (Friday prayer's orator) and religious teacher in Masjid al-Haram Makkah, appointed by the Holy Land's authority. Many of his students came from the Malay region. In these two books were mathematical topics of the period found in the Muslim world, which included number theory, algebra, geometry, trigonometry, approximation theory and discussions on daily problems specially those arising from Islamic practices (*fiqh*) and the like. The contents of these works reflected the discussions and debates that took place in the period that began in 9th century and ended in the 17th, especially on the works of Muhammad bin Mūsā al-Khwārizmī produced during the late 8th and early 9th centuries. Also included were those by Abū Kāmil Shuja' al-Aslam (10th century), Abū Bakar al-Karajī (11th century), Ibn al-Yāsāmīn (12th century) and Ibn al-Bannā' (14th century), Ibn Hamzah al-Maghribī (16th century) and Bahā'uddīn al- 'Āmilī (17th century).

Al-Khatib's approach in the teaching of mathematics was almost exclusively influenced by the traditional methods of teaching from the scholars of the early Muslim period which clung to the descriptive way of solving problems. Although symbolism was already introduced in the Islamic world as early as at the time of al-Khwārizmī and further popularised by Abū Kāmil, al-Maghribī and later by al-Qalsaldī in Spain (15th century), Malay Muslim mathematicians were not responsive to the idea of adopting the symbolism approach (Ismail (2004). Descriptive representation of mathematical problems is the special feature of the curriculum in mathematics education outlined above, as demonstrated by the content of the book '*Alam al-Hussāb fi 'Ilm al-Hisāb* by al-Khatib, a representative of works written in the Malay language in the 19th century.

Umar Nurudin's work on the distribution of properties left behind by deceased members of the family was entitled *Pelajaran Membahagi Pesaka* (Lessons in Distribution of Inheritance) (early 19th century). His other works include *Shams al-Fathhiyyah fi A'māl al-Juyūb* (The Guiding Light to Success in the Art of Trigonometry) or *al-Jaibiyyah* (The Art of the (Trigonometrical) Sine) (1925), *Rubu' al-Mujayyab* (The Quadrant of the (Astronomical) Sine) (date unknown) and *Miftāh al-Ta'alīm* (The Key to Teaching and Learning) (1924). In the early 20th century a scholar by the name of Muhamad Nur al-Ibrahimi, from Sumatra Indonesia, wrote a treatise on logic called '*Ilm Mantiq* (The Art of Logic) (1931). Sheikh Muhammad Nur Ibrahim of Kelantan wrote a book *Bantuan Ketika Bagi Orang yang Membahagi Pusaka* (A People's Guide to Inheritance Problems) (1936). Earlier, in 1932 he published a book entitled *Pilihan Mastika pada Menerangkan Qiblat dan Ketika* (Selected Gems in the Calculation of Qibla Direction and (Prayer) Times), on the exact Qibla location in Mecca. Syeikh Tahir Jalaluddin of Sumatran origin, wrote a book on the mathematical method of determining Muslim prayer times, entitled *Pati Kiraan pada Menentukan Waktu yang Lima dengan Logaritma* (The Essence of Calculations Related to the Five Prayer Times Using Logarithm) in 1938. He also authored two other books on astronomy and wealth distribution. His book on astronomy entitled, *Risā'il fi'l-Falak* (Treatises on Astronomy), contained an article by one Abdul Rahman Kelantan bin Muhamad al-Battul which was dated 1826. In our view, this may be the oldest extant treatise on astronomy ever found in the Malay language.

As can be seen, due to its relevance and importance in determining the prayer times and direction of qibla, the mathematics branch of trigonometry became part and parcel of the curriculum in the traditional Islamic Schools. Students were taught the rudiments of trigonometry as how the subject was taught in centres of learning in Mecca, Medina and Cairo by their teachers who had studied in these places. Along with that they were also introduced to the applications of the astrolabes, quadrants and sundials invented in the middle east, to determine the periodical positions of the constellation of stars in space. One such astrolabe can be found as late as 1957 in mainland Penang, Malaysia in the religious school Daeratul Maarif al Wataniah (Nor Azam Mat Noor (2004)). It was frequently used by Syekh Abdullah Fahim a Malaysian astronomer who was also the state's Mufti.

Among the astronomers in the Malay region, astrolabes are not as widely used as the quadrants. According to King (1987), a quadrant is a complete instrument containing universal trigonometric grids invented by Ibn Syatir in the 14th century. However, the quadrants used in the Malay region are of more simpler version and limited use. Sheikh Tahir Jalaluddin in his work *Pati Kiraan* (1938) besides applying logarithmic functions used the quadrant to determine a trigonometric function ratio (Baharrudin (2004, 2009)).

Sundials are traditional instruments which were widely used in this region. They are still found in use in mosques, especially old ones, in the states of Malacca and Johore of Malaysia (Baharrudin (2002)). The existence of this artifact demonstrates the fact that sundials were once used to determine the times for workshop by the Muslims. Theoretically, at least, the construction and use of these instruments would require knowledge in mathematics, geometry and astronomy (Baharrudin (2004)).

6. Units of Measures

Among the daily activities in a Malay Muslim society is the conducting of business transactions. Bartering, weighing and using other means were characteristic activities in Muslim markets. All of these are closely connected to the ability to compute based on agreed principles. In his book *'Alam al-Hussāb*, al-Khatib gave examples of the units of measures which were in use during that time. These include *sen*, *ringgit* and *rupiah* as currency units, *pikul*, *kati*, *saga*, *kundi*, and *bungkal* as weight measures, *hasta* and *depa* for length units and *cupak*, and *gantang* for volume. Further discussions on the topic of measures according to al-Khatib can be found in his book in Arabic entitled *Sulh al-Jamā'ain* (Conciliation of the Two Parties). Quizzes were also included in al-Khatib's books. They ranged from topics on multiplication and division to determinations of square roots based on real life problems. Among the topics covered in this book are *permulaan hisab* (elementary arithmetic), *haqīqah bilangan* (on counting principles), *hitungan sahih* (on the integers), *kumpulan* (addition), *kurangan* (subtraction), *pukulan* (multiplication), *jenis-jenis pukulan* (types of multiplication), *bahagian* (division), *nisbah al-muttasilah hisābiyah* (arithmetic progression), *al-mutta silah handasiyah* (geometric progression), *kaifiat mengetahui yang majhul* (systems of equations), *tabādul* (permutations), *kaifiat bilangan kali-kali mungkin* (combinations), *amal dua yang tersalah* (approximations method; golden rule), *aljabr wa al-muqābalah* or *amal dengan bertemper dan berkebetulan* (the term in Malay language for the *algebra* of al-Khwarizmi and solutions to quadratic equations), *al-mishaah* (plane geometry) and *al-mīzān* (modular congruence). Most of the topics covered by this book are taught in modern day Malaysia. An interesting feature of this book, which was also admitted by the author, was the striking similarity between its content and that of the book *Khulāsah al-Hisāb* written by Bahā'uddīn al-Āmilī (17th century) which was one of the many links in the chain of Islamic mathematical tradition which had begun from the time of al-Khwārizmī.

7. Conclusion

The motivating factors in the teaching of mathematics in the Islamic system of education in the Malay Archipelago are tied to the need to comprehend the basic teachings of the religion and efficient implementation of the administrative procedures as outlined by regulations stipulated by Islamic jurisprudence (fiqh) that governs everyday activities in the life of a Muslim. This was the dominant factor in the determination of mathematics education in the Islamic school curriculum prior to the introduction of the secular school system brought by the western colonialists in the late 19th century.

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